

Annual Report from Peter L. Tyack for N00014-97-1-1031

Responses of whales to experimental playback of low frequency sound from the Navy SURTASS LFA

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ONR Program Officer: Robert Gisiner

The instructions for the annual report have conflicting dates. I take this year to go from 1 July 1998 to 30 June 1999, not the 12 months ending 30 Sept 1999.

Long-term Research Objective:

Low frequency sound produced by human activities poses a potential risk to marine life, especially marine mammals. There is an urgent need to understand what levels of exposure to sound pose a risk of behavioral disruption in marine mammals. The overall objective of this study is to evaluate the effects of low frequency sound on the behavior of those marine mammal species judged to be most sensitive or vulnerable to low frequency sound in the wild.

Q: S&T Objectives:

Characterize the responses of fin and blue whales feeding in the Southern California Bight, gray whales migrating past the California coast and humpback whales singing offshore of the Big Island of Hawaii to experimental playback of low frequency sounds from the SURTASS LFA sound source.

Q: Approach:

Whales were given controlled exposures of noise from the SURTASS LFA vessel in the context of carefully controlled experimental observations. Observers on shore and on the source vessel tracked the movement patterns of whale groups with respect to the sound source. Fin and blue whales and singing humpback whales were followed by an observation vessel and tracked acoustically in order to monitor vocal responses to playback. Responses of all whales were related to received level of acoustic exposure.

Q: S&T Completed:

My lab has been analyzing results from the SURTASS LFA marine mammal study, all of which occurred in the year before this period. We have prepared final plots and double checked all of the data, and are nearing completion on final analyses of these data. The major task for the next year will be final write up. I have also given tens of briefings on the SURTASS LFA marine mammal study and have helped review the SURTASS LFA DEIS and advise the team preparing it

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Q: Impact / Navy Relevance:

The data resulting from this study are critical for providing guidelines as to what kinds of exposure to low frequency sound may pose a risk to marine mammals. These data are critical for the SURTASS LFA DEIS as well as for developing a policy within the Navy and outside of the Navy for how low frequency sound sources may be operated without adverse impact to populations of marine mammals which are protected by the U.S. Marine Mammal Protection Act and Endangered Species Act.

Q: Planned Research Efforts:

This award expired 4/07/99. The results of the SURTASS LFA marine mammal research program are critical for developing policy regarding the impact of Navy active acoustic operations on behavioral disruption of marine mammals. It is imperative that the results be published in peer reviewed journals. My major effort on this specific project will involve completion of analysis and write up, along with presenting the results to the scientific and policy communities.

Q: Planned S&T Efforts:

No next year on this award. I am developing digital acoustic recording tags for work with right whales and deep diving toothed whales as a more sensitive response measure for further studies involving controlled exposures of noise to marine mammals in the wild. These projects are supported by ONR, but the funds were not awarded until after the period covered by this report.

Q: Technology Transfer:

The funding for this research is being continued by Marine Acoustics, Incorporated. There has been strong interest in the results by Federal regulators of noise and marine mammals, by the oil industry, and by environmental NGOs. This research is highly relevant for any sea-going activity that produces low frequency sound, or by any parties interested in the effects of ocean noise on marine life.

Q: References:

A: "Cite appropriate references."

Q: Other Sponsored Science & Technology:

A: "Provide the following information for each award you have from other research or development sponsoring agencies: Title: Sponsoring agency: Total funding: Start date of the award: End date of the award: Describe in a few lines the objective of the research or technology effort: For privately funded efforts where proprietary agreements limit your ability to release this information, please discuss this with your ONR Program Officer."

Title	Sponsoring Agency	Total funding	Start-End Date
Sounds of the Sea Project	New England Aquarium (NSF Subcontract) ESI-9705519	\$110,664	7/1/97- 6/30/99
Pilot Test of an Acoustic Recording Tag to Measure Right Whale Responses to an Approaching Vessel	Mass. Environmental Trust (WHOI #45234600)	\$30,000	1/1/98- 6/30/99
Using an Acoustic Recording	Mass. Environmental	\$24,579	10/1/98-

Tag to Measure Right Whale Responses to an Approaching Vessel	Trust (WHOI #45980400) RFR# MET 98-04		6/30/00
Functions of Signature Whistles	Waikoloa Marine Life Fund Dolphin Quest #25199700	\$20,137	2/1/98- 12/31/99
Analysis of Reporting of SURTASS-LFA Marine Mammal Research	Marine Acoustics, Inc. (NUWC Subcontract MAI-98-06)	\$150,000	12/04/98- 11/30/99
Digital Recording Tag to Measure the Response of Northern Right Whales to Sound	Green Technology	\$30,000	12/1/98- 11/30/99
Social Functions of Signature Whistle Imitation in Free Ranging Bottlenose Dolphins	National Geographic Society	\$19,365	6/1/99 - 08/31/99
Demonstrating a New Tool to Study Coastal Marine Mammals: Source Levels, Directionality, and Signature Information in Killer Whale Calls	Rinehart Coastal Research Center	\$10,000	6/1/99- 12/31/00
ATOC MMRP Advisory Board	Cornell University	\$3,752	5/1/99
Social Functions of Signature Whistles and Whistle Imitation in Bottlenose Dolphins, <i>Tursiops truncatus</i>	National Science Foundation	\$192,163	8/1/99 7/31/02
Pilot Test for Attaching Tags to Deep Diving Toothed Whales	Office of Naval Research	\$90,600	5/20/99- 1/1/00
Assessing Risk Factors in Right Whale Vessel Collision Using an Acoustic Recording Tag and Controlled Sound Exposure	Office of Naval Research	\$80,000	5/25/99- 9/30/00
Controlled Exposures of Right Whales to Sound in the Bay of Fundy	International Fund for Animal Welfare	\$15,224	7/1/99- 10/31/99

Q: Visual (optional):

A: "Provide a visual using a PC compatible format (e.g. JPEG) representing your program or an accomplishment and a caption to accompany the visual. This visual will be available to the public and other funding agencies."

Q: Subcontractors (Organization; Address; Contact; Tasking; Funding provided this year):

A: "List any formal subcontracts associated with the ONR S&T effort."

Q: Productivity:

A: "For the period 1 July 1998 through 30 June 1999, list your productivity as a result of the ONR Award under the following categories. At least 1/4 th of the cited effort must be supported directly from your ONR funding. Use complete citations in each category; do not include 'submitted', 'accepted', etc. for published items or presentations scheduled after 31 June. Not all categories are appropriate for each investigator."

Q: Journal publications appearing in print:

- 1999 Tyack P. Playback experiments of loud low frequency sound to singing humpback whales in Hawaiian waters. *Whalewatcher* 37(1):3-12.
- 1998 Tyack P. Protecting marine mammals from the growing problem of ocean noise: opportunities and problems. *MMPA Bulletin* 13:8-9.
- 1998 Burgess, W.C., P.L. Tyack, B.J. LeBoeuf, and D.P. Costa. A programmable acoustic recording tag and first results from free-ranging northern elephant seals. *Deep-Sea Research* 45:1327-1351
- 1998 Miller P and P.L. Tyack. A small towed beamforming array to identify vocalizing resident killer whales (*Orcinus orca*) concurrent with focal behavioral observations. *Deep-Sea Research* 45:1389-1405.
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Q: Formal technical reports released by your institution:

- 1998 Clark, C.W. and P.L. Tyack. Quick look low-frequency sound scientific research program phase III: Responses of Humpback Whales to SURTASS LFA off the Kona Coast, Big Island Hawaii 26 February - 31 March, 1998
- 1998 Tyack, P.L. and C.W. Clark. Quick look -- Playback of low frequency sound to gray whales migrating past the central California coast - January, 1998.
- 1998 Clark, C.W., P.L. Tyack, and W.T. Ellison. Quick look, phase I, Low frequency sound scientific research program.
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Q: Presentations (indicate invited presentations):

- 1998 Present preliminary results from SURTASS LFA research. LFS SRP public outreach meeting. Phase II results, Crystal City VA 30 June 1998
- 1998 Acoustic pollution and marine mammals. Global Legislators Organization for a Balanced Environment. Brewster MA 25 August 1998.
- 1998 Workshop on Acoustic Criteria, National Marine Fisheries Service Office of Protected Resources Silver Spring MD 9-12 September 1998
- 1998 Review preliminary results from SURTASS LFA research phases II and III. SURTASS LFA scientific working group meeting #3, 15-16 September 1998
- 1998 Marine mammals and sound in the sea. Knight science journalism fellows. Woods Hole 1 October 1998.
- 1998 Effects of low frequency noise on marine mammals, Marine Mammal Commission annual meeting, November 1998

- 1998 Effects of low frequency noise on marine mammals, Environmental Biology Seminar Series, MIT, 4 December 1998
- 1998 Effects of noise on marine mammals, Marine Mammals, Brandeis University, Prof. James Hain. 18 December 1998
- 1999 Brief Minority Staff Director of House Committee on Armed Services, WHOI, 2 April 1999
- 1999 Data acquisition -tagging. Navy Marine Mammal Requirements Workshop, Crystal City, 7 April
- 1999 Perspectives on behavioral modification, Navy Marine Mammal Requirements Workshop, Crystal City, 8 April 1999
- 1999 Briefing on scientific results of LFA whale study, Crystal City, SURTASS LFA OEIS/EIS meeting, 9 April 1999
- 1999 Scientific results of SURTASS LFA marine mammal research program, Committee to review results of ATOC's marine mammal research program, National Academy of Sciences, San Diego CA, 12-14 April 1999
- 1999 Are whales harmed when humans introduce loud sounds into the ocean? Lowell Lecture Series, New England Aquarium, Boston MA, 29 April 1999
- 1999 Brief California Coastal Commission on results of phase II of SURTASS LFA SRP, Santa Rosa CA, 12 May 1999
- 1999 Marine mammals and manmade noise. WHOI Trustees Meeting, WHOI, 14 May 1999
- 1999 Effects of noise on marine mammals, Marine Technology Society/Naval Undersea Warfare Center, Newport Rhode Island, 18 May 1999
- 1999 Review results of National Academy of Sciences Committee to review results of ATOC's marine mammal research program, Advisory Board, ATOC MMRP, 19-21 June 1999.
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Q: Books or book chapters published:

- in press Gordon J and P.L. Tyack. Acoustic techniques for studying cetaceans. In: Marine mammals: biology and conservation. (P.G.H. Evans and T. Raga, eds), Plenum Press, London.
- in press Gordon J and P.L. Tyack. Sounds and Cetaceans. In: Marine mammals: biology and conservation. (P.G.H. Evans and T. Raga, eds), Plenum Press, London.
- in press Tyack, P.L. Communication and acoustic behavior of dolphins and whales. In: Hearing by whales and dolphins. (W. Au, A.S. Popper, and R. Fay eds), Springer Handbook of Auditory Research Series, Springer Verlag, New York.
- 1998 Tyack, P. Acoustic communication under the sea. In: *Animal acoustic communication: recent technical advances*. (S.L. Hopp M.J. Owren, and C.S. Evans, eds.), Springer Verlag, Heidelberg, pp 163-220.

Q: Patents (indicate status, e.g., filed, issued): None

Q: Honors, awards or prizes received during the reporting year:

Promotion from Associate Scientist with tenure to Senior Scientist.

Q: Number of Students Supported (minimum of 1/4 of their support):

2

Q: Post Doctoral: ____ Doctoral: 2 Q: Masters: ____ Undergraduate: ____

Q: Of these students, the number who were:

Q: Females: 0

Q: Under-represented Ethnic groups: 0 (Under-represented or minority groups include Blacks, Hispanics, Pacific Islanders and Native Americans. Asians are not considered an under-represented or minority group in science and engineering)

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<p>13. Abstract</p> <p>The objectives of this study were to characterize the responses of whales to experimental playback of low frequency sounds from the SURTASS LFA sound source. The study involved three different field studies: the first phase involved fin and blue whales feeding in the Southern California bight, the second phase involved gray whales migrating past the California coast and the third phase involved humpback whales singing offshore of the Big Island of Hawaii. Observers on shore and on the source vessel tracked the movement patterns of whale groups with respect to the sound source. Fin and blue whales and singing humpback whales were followed by an observation vessel and tracked acoustically in order to monitor vocal responses to playback. We have presented preliminary results from each phase in several meetings and in quick look reports and are completing analyses and writing up results for submission to peer reviewed scientific journals.</p>			
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